

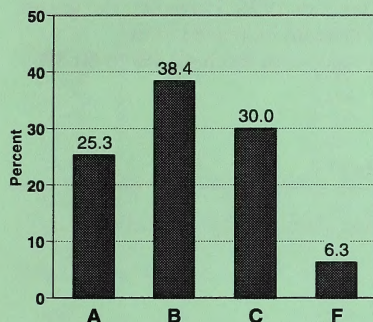
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Biology 30

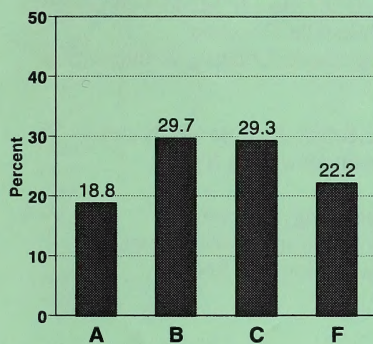
Diploma Examination Results

Examiners' Report for January 1998

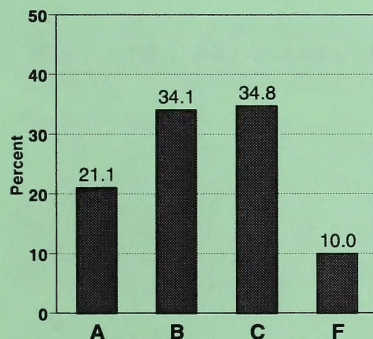
School-Awarded Mark



Diploma Examination Mark



Final Course Mark



The summary information in this report provides teachers, school administrators, students, and the general public with an overview of results from the January 1998 administration of the Biology 30 Diploma Examination. This information is most helpful when used with the detailed school and jurisdiction reports that have been provided electronically to schools and school jurisdiction offices. A provincial report containing a detailed analysis of the combined January, April, June, and August results is made available annually.

Description of the Examination

The Biology 30 Diploma Examination consists of 48 multiple-choice questions worth 60%, eight numerical-response questions worth 10%, and two written-response questions worth 30% of the total examination mark.

Achievement of Standards

The information reported is based on the final course marks achieved by 7 354 students in Alberta who wrote the January 1998 examination. This represents a decrease of 333 students compared with January 1997 and a decrease of 316 students compared with January 1996.

- 90.0% of the 7 354 students achieved the acceptable standard (a final course mark of 50% or higher).
- 21.1% of the 7 354 students achieved the standard of excellence (a final course mark of 80% or higher).

Generally, student achievement in Biology 30 was good. However, the percentage of students who achieved the acceptable standard (90.0%) was slightly less than the percentage for January 1997 (92.1%). Most students demonstrated a very good understanding of human reproductive, endocrine, and nervous systems and hormones. They demonstrated a good understanding of concepts related to molecular and population genetics and the interaction of populations. Some students had difficulty with concepts related to differentiation, development, cell division, and Mendelian genetics. The majority of students were able to demonstrate a very good understanding of science, technology, and society connections, but some students had difficulty describing and evaluating scientific research procedures.

Approximately 61.1% of the students who took the course were female. Of these female students, approximately 90.8% achieved the acceptable standard on the course, compared with 88.7% of the male students. The standard of excellence was achieved by approximately 22% of these female students, compared with 20% of the male population.

Provincial Averages

- The average school-awarded mark was 69.1%.
- The average diploma examination mark was 63.4%.
- The average final course mark, representing an equal weighting of the school-awarded mark and the diploma examination mark, was 66.5%.

Approximately 7.8% of the students who wrote the examination in January 1998 and received a school-awarded mark had written at least one

other Biology 30 Diploma Examination during the January 1996 to January 1998 period. This subpopulation (574) achieved an examination average of 60.3%, compared with 63.6% for the population (6 780) who first wrote the Biology 30 examination in January 1998. However, the group of students who rewrote increased their examination average score from 49.4% to 60.3%.

Results and Examiners' Comments

This examination has a balance of question types and difficulties. It is designed so that students achieving the acceptable standard will obtain a mark of 50% or higher, and students achieving the standard of excellence will obtain a mark of 80% or higher.

In the following table, diploma examination questions are classified by question type: multiple choice (MC), numerical response (NR), and written response (WR). The column labelled "Key" indicates the correct response for multiple-choice and numerical-response questions. For numerical-response questions, a limited range of answers was accepted as being equivalent to the correct answer. For multiple-choice and numerical-response questions, the "Difficulty" indicates the proportion (out of 1) of students answering the question correctly. For written-response questions, the "Difficulty" is the mean score achieved by students who wrote the examination.

Questions are also classified by general learner expectations.

Knowledge:

- GLE 1 Nervous & Endocrine Systems
- GLE 2 Reproductive Systems & Hormones
- GLE 3 Differentiation & Development
- GLE 4 Cell Division & Mendelian Genetics
- GLE 5 Molecular Genetics
- GLE 6 Population Genetics & Interaction

Skills:

- SPC Scientific Process Skills and Communication Skills

Science, Technology, Society:

- STS Connections Among Science, Technology, & Society

Blueprint

Question	Key	Difficulty	GLE 1	GLE 2	GLE 3	GLE 4	GLE 5	GLE 6	SPC	STS
MC1	B	0.665	✓							
MC2	C	0.673	✓							
NR1	2314	0.627	✓							
MC3	D	0.721	✓							
MC4	A	0.780	✓							✓
MC5	B	0.691	✓							
MC6	C	0.667	✓							
MC7	C	0.487	✓							
MC8	A	0.814	✓							✓
MC9	D	0.765	✓							
MC10	C	0.671	✓							
MC11	D	0.800	✓							
MC12	D	0.745	✓							✓
MC13	A	0.567	✓						✓	
MC14	A	0.778	✓							
MC15	C	0.704	✓							✓
MC16	C	0.773	✓							
MC17	B	0.575	✓							✓

Question	Key	Difficulty	GLE 1	GLE 2	GLE 3	GLE 4	GLE 5	GLE 6	SPC	STS
MC18	A	0.874		✓						✓
MC19	D	0.731		✓						
MC20	D	0.913		✓						
MC21	C	0.752		✓						
MC22	A	0.855				✓				
MC23	C	0.587		✓						
MC24	A	0.587		✓						
MC25	B	0.759		✓						✓
MC26	B	0.770			✓					
MC27	C	0.706		✓					✓	
MC28	D	0.902		✓						
MC29	B	0.678			✓				✓	
MC30	B	0.707				✓			✓	✓
MC31	A	0.693				✓				✓
NR2	2133	0.394			✓				✓	
MC32	A	0.842				✓			✓	✓
MC33	B	0.700				✓				
MC34	D	0.699				✓				✓
MC35	B	0.620				✓			✓	✓
MC36	D	0.508				✓			✓	
MC37	C	0.829					✓			✓
NR3	32.5	0.528					✓		✓	
MC38	D	0.386				✓			✓	
NR4	3193	0.609				✓			✓	
MC39	A	0.606				✓			✓	
MC40	C	0.746				✓			✓	
NR5	25	0.667				✓			✓	✓
MC41	D	0.501				✓			✓	
MC42	B	0.715					✓		✓	
MC43	A	0.524				✓			✓	
MC44	D	0.623				✓			✓	
MC45	B	0.718				✓			✓	
MC46	B	0.412				✓			✓	
NR6	0.32	0.427						✓	✓	✓
NR7	0.75	0.651				✓			✓	✓
MC47	A	0.855						✓	✓	
NR8	0.60	0.625						✓	✓	
MC48	C	0.512						✓	✓	
WR1		0.507				✓(4)	✓(5)	✓(3)	✓(5)	✓(3)
WR2		0.544			✓(4)			✓(8)	✓(4)	✓(2)

Subtests: Machine Scored and Written Response (Average by Subtest)

When analyzing detailed results, bear in mind that subtest results **cannot** be directly compared. Results are in average raw scores.

Machine scored: 37.7 out of 56
 Multiple choice: 33.2 out of 48
 Numerical response: 4.5 out of 8

Written Response: 12.8 out of 24
 Question 1: 6.1 out of 12
 Question 2: 2.2 out of 4

Raw Score Averages for Machine-Scored Items and Written-Response Question 1 by General Learner Expectations

General Learner Expectations:

GLE 1	Nervous & Endocrine Systems	12.5	out of	18
GLE 2	Reproductive Systems & Hormones	6.8	out of	9
GLE 3	Differentiation & Development	1.8	out of	3
GLE 4	Cell Division & Mendelian Genetics	13.3	out of	23
GLE 5	Molecular Genetics	5.0	out of	8
GLE 6	Population Genetics & Interaction	4.4	out of	7
Skills	Scientific Process and Communication Skills	19.6	out of	32
STS	Connections in Science, Technology, and Society	13.4	out of	19

Multiple-Choice and Numerical-Response Questions

The following table gives results for 6 questions selected from the examination. The table shows the percentage of students in four groups that answered the question correctly. The comments following the table discuss some of the understandings and skills the students may have used to answer these questions.

Percentage of Students Correctly Answering Selected Machine-Scored Questions

Student Group	Question Number						
	NR1	MC13	MC36	NR4	MC43	NR6	NR8
All Students	62.7	56.7	50.8	60.9	52.4	42.7	62.5
Students achieving the <i>standard of excellence</i> (80% or higher, or A) on the whole examination	90.2	62.8	77.9	86.4	71.3	85.6	93.5
Students achieving the <i>acceptable standard</i> (between 50% and 79%, B or C) on the whole examination	63.9	60.1	49.2	65.4	51.8	41.9	66.2
Students who have not achieved the <i>acceptable standard</i> (49% or less, or F) on the whole examination	36.0	42.6	32.1	27.2	37.9	8.4	26.3

Use the following information to answer the next question.

Processes That Occur at a Neuromuscular Junction (A Type of Synapse)

- 1 Muscle fibres contract when sodium gates open allowing sodium ions to diffuse into the muscle cytoplasm.
- 2 Acetylcholine is released from the axon terminal.
- 3 Acetylcholine binds to the receptors on the muscle cell.
- 4 Cholinesterase breaks down acetylcholine, and the sodium gates close.

—from Guyton

Numerical Response

1. An impulse arrives at an axon terminal that synapses with a muscle cell. Record the processes in the order that they occur at the synapse.

(Record your **four-digit answer** in the numerical-response section of the answer sheet.)

Answer: 2314

Use the following information to answer the next question.

In 1947, E. B. Verney published the results of a series of experiments that he had conducted on a number of dogs. He found that if he injected a concentrated salt solution into the bloodstream, hypothalamus, and ventricles of the brain, hormone "X" was released in large amounts.

13. Hormone "X" was most likely

- *A. ADH
- B. ACTH
- C. oxytocin
- D. aldosterone

Numerical-response question 1 required students to sequence the processes occurring at a neuromuscular junction. Students achieving at the standard of excellence were readily able to sequence these processes; however, most of the other students had some degree of difficulty. Of these students, the most common error was the incorrect placement of the process "Muscle fibres contract when sodium gates open allowing sodium ions to diffuse into the muscle cytoplasm" in the sequence. This seems to indicate that these students do not recognize that acetylcholine binding to receptors on muscle causes the sodium gates in muscle fibres to open and the muscle fibre to contract.

Multiple-choice question 13 required students to select the hormone that would be released in large amounts when a concentrated salt solution was injected into dogs. In general, most students had difficulty identifying hormone "X" as ADH. The most common error was identifying the hormone as aldosterone. Although both hormones are affected by salt solutions, a concentrated salt solution will stimulate cells in the hypothalamus to stimulate the posterior pituitary to release ADH.

Use the following information to answer the next question.

A Cellular Structure Found During Mitosis



36. This diagram of a cellular structure shows

- A. one crossed-over pair of chromosomes
- B. two homologous chromosomes
- C. one tetrad of chromatids
- *D. two sister chromatids

Numerical Response

4. The F_2 seed phenotype ratio that Mendel obtained upon crossing two heterozygous smooth and yellow F_1 individuals would have been _____.

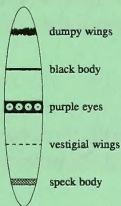
(Record your **four-digit answer** in the numerical-response section of the answer sheet.)

Answer: _____ : _____ : _____ : _____
 smooth and green wrinkled and green smooth and yellow wrinkled and yellow

Answer: 3193

Use the following information to answer the next question.

Locations of Some Genes on a Section of a *Drosophila* Chromosome



43. During meiosis, which pair of genes have the **best** chance of being transferred **together** to a new cell?

- *A. Black body and purple eyes
- B. Purple eyes and speck body
- C. Dumpy wings and purple eyes
- D. Dumpy wings and speck body

Multiple-choice question 36 required students to identify the cellular structure found during mitosis illustrated in the diagram. In general, most students had difficulty identifying the structure to be two sister chromatids. The most common error was identifying the structure to be a tetrad. However, this error was not made by the students achieving at a standard of excellence. A tetrad consists of a pair of replicated chromosomes. The structure diagrammed is also referred to as a single replicated chromosome.

Numerical-response question 4 required students to determine the phenotypic ratio for a dihybrid cross between two heterozygous individuals. Students achieving at the standard of excellence were readily able to correctly match the phenotypes with the correct ratio; however, most other students had some degree of difficulty. Of these students, the most common error, made by 15.9% of students, was to record the phenotypic ratio as 9331. This would have been the result of using the phenotypic ratio for a heterozygous dihybrid cross without reference to the actual phenotypes to which these numbers apply. Two possible errors on the students' part might explain this. Students may be memorizing the phenotypic ratio without truly understanding how to do a dihybrid cross, identify the phenotypes produced, and determine a correct ratio. Alternatively, students may have failed to read the question carefully.

Multiple-choice question 43 required students to choose the pair of genes that would have the best chance of being transferred together to a new cell. Genes that are located close together on a chromosome cross over less frequently than genes that are located far apart. As a result, the close genes have the best chance of being transferred together. In general, most students had difficulty selecting the two closest genes, black body and purple eyes, as the correct answer. Of the students having difficulty, the most common error was to choose the two farthest genes, dumpy wings and speck body.

Use the following information to answer the next question.

In sheep, white wool is a dominant trait and black wool is a recessive trait. In a herd of 500 sheep, 20 sheep have black wool.

Numerical Response

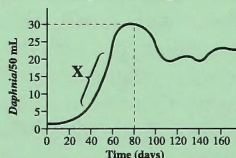
6. In this herd, what is the frequency of the heterozygous genotype?

(Record your answer as a value from 0 to 1, rounded to two decimal places, in the numerical-response section of the answer sheet.)

Answer: 0.32

Use the following information to answer the next question.

The Changes in a *Daphnia* Population Over Time



The graph represents a population of *Daphnia* (water fleas) cultured in a stable nutritional environment.

—from Campbell

Numerical Response

8. The density of *Daphnia* on day 80 is _____/mL.

(Record your answer rounded to two decimal places in the numerical-response section of the answer sheet.)

Answer: 0.60

Numerical-response question 6

required students to calculate the frequency of the heterozygous genotype in a herd of 500 sheep. This was very difficult for most students. However, students achieving at the standard of excellence were readily able to perform this calculation. About 12% of all students calculated the frequency to be 0.04, or q^2 , the first part of the calculation. About 6% of all students calculated it to be 0.08 or $2q^2$, instead of $2pq$.

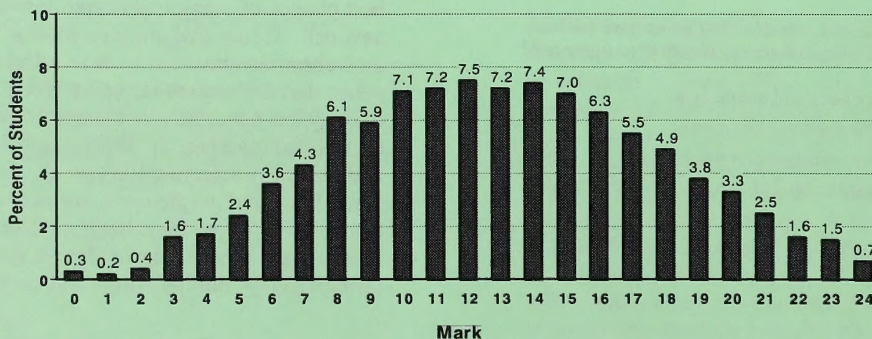
Numerical-response question 8

required students to calculate the population density of *Daphnia*. They had to take the required data for the calculation from a graph representing a population of *Daphnia* cultured in a stable nutritional environment over time. This was difficult for most students, but students achieving at the standard of excellence were readily able to perform this calculation. About 7% of all students calculated the density to be 0.38 because they used time (80 days) instead of volume (50 mL) in their calculation. About 6% of all students chose 30 as their density; this represents 30 *Daphnia* in 50 mL of culture, and the question asked for number of *Daphnia* per mL.

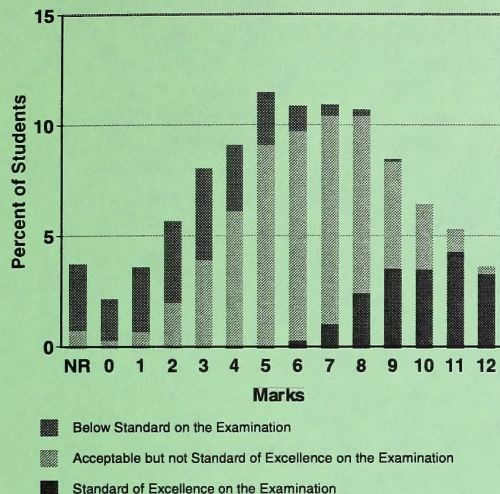
Written-Response Questions

Of the students who wrote the examination, 0.2% received no marks for both written-response questions, 67.3% received 12 marks or more out of 24, and 17.6% received 20 marks or more out of 24.

Distribution of Marks for Written Response



Distribution of Marks for Question 1



Question 1 Almost all students (99.7%) who wrote the examination received some marks on this process skill question related to biomimetics. The properties of spider silk, its production, and its biosynthesis are the aspects of biomimicry presented in this question.

The mean of part a was approximately 69%, indicating that students were able to decode DNA and successfully analyze the resulting polypeptide. Unfortunately, some students translated from tRNA or the complementary strand of DNA. In their analysis of the resulting polypeptide, students had to determine if it was elastic or tough and then explain their reasoning. Most students indicated that the polypeptide would be elastic because it was glycine-rich. Some students answered “yes, it would be elastic or tough,” and others failed to explain why it would be elastic.

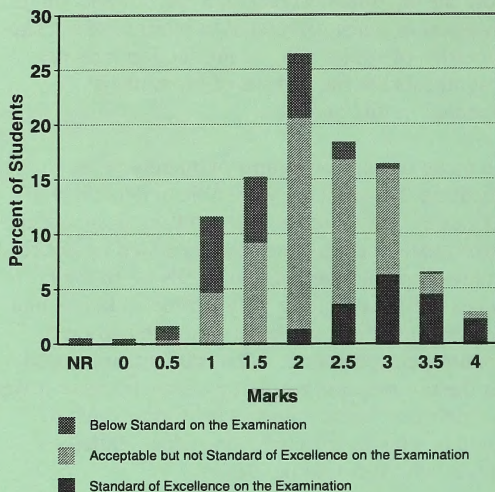
The mean of part b was approximately 30%, indicating that students had difficulty understanding the cell cycle and determining when protein synthesis (silk production) occurs. Many students thought that the cell cycle was somehow illustrated in the diagram of the spider, misunderstanding the cellular nature of organisms. Some students confused the cell cycle with mitosis, some indicated, incorrectly, that DNA replication occurs in prophase, and some indicated, again incorrectly, that silk production occurs in mitosis. Although the three expected answers were the activities of interphase, the nuclear division of the cell (mitosis), and the division of the cytoplasm (cytokinesis), markers agreed to accept specific activities of the cell as they related to the above three main activities of the cell cycle.

The mean of part c was approximately 45%, indicating that students also had difficulty explaining a procedure of a biotechnology. Many students did not identify the enzymes by name, and some students confused cloning with recombinant DNA. Those students who did not name the enzymes involved, but described the process of insertion sufficiently, earned one mark out of two.

The mean of part d was approximately 64%, indicating that, in general, students were able to define mimicry and to judge the appropriateness of the term biomimicry. Students who had difficulty with this question used the root word mimic in their definition and or were unable to develop a sound argument for or against the use of the term biomimicry.

On this 12-mark question, the average mark was 6.1, or 50.7%. The acceptable standard on this question was achieved by 56.3% of the student population, with 15.3% achieving the standard of excellence with scores of 10, 11, or 12 marks ($\geq 83\%$). Although this was a difficult question for the students, approximately the same proportion of students achieved the standard of excellence as on the whole examination (18.8%). Of the female students who wrote the examination, 58.8% achieved the acceptable standard and 15.7% achieved the standard of excellence. The average mark on this question for the female population was 51.8%. Of the male students who wrote the examination, 52.4% achieved the acceptable standard and 14.8% achieved the standard of excellence. The average mark on this question for the male population was 48.9%.

Distribution of Marks for Question 2



Question 2 Approximately 99% of the students who wrote this examination received some marks on this essay question. The question required students to identify and describe relationships, population sizes, and behaviours of wolves, coyotes, and elk. Students also had to determine the reproductive strategy of the wolf, explain factors affecting wolf population growth and genetic diversity, and explain one reproductive technology that would increase north-south gene flow.

Students described the relationships among wolves, coyotes, and elk, explained the factors affecting wolf population growth, and explained a reproductive technology very well. The most commonly described reproductive technologies were *in vitro* fertilization and artificial insemination. Students confused the terminology

for relationships, using terms like parasitism and mutualism for predation. They had difficulty identifying the wolf reproductive strategy (K-selected), but they generally described the strategy well. Students also had difficulty describing how the genetic diversity of an isolated wolf population would decrease, with some students confusing decreased genetic diversity with a reduction in population size. Most students did not address how the variety of alleles could change in an isolated population. In general, students addressed all parts of this question, presented unified, well-written, organized essays, and demonstrated the scientific background to answer this question.

This question was marked holistically. Two markers read each response, and each assigned a score from 0 to 4. These scores were added, then divided by 2 to obtain a raw score from 0 to 4. This raw score was then converted to a mark out of 12. On this 12-mark question, the average mark was 55.0%. The acceptable standard on this question was achieved by 70.6% of the student population, with 9.4% achieving the standard of excellence. Of the female students who wrote the examination, 72.8% achieved the acceptable standard and 10.8% achieved the standard of excellence. The average mark on this question for the female population was 55.9%. Of the male students who wrote the examination, 67.0% achieved the acceptable standard and 7.2% achieved the standard of excellence. The average mark on this question for the male population was 52.0%.

Markers would like to encourage students not to sign their papers and to write their answers in blue or black ink.

For further information, contact Karen Slevinsky (kslevinsky@edc.gov.ab.ca) or Corinne McCabe (cmccabe@edc.gov.ab.ca) at the Student Evaluation Branch at 427-0010. To call toll-free from outside of Edmonton, dial 310-0000.

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